

CONCRETING
— IN —
COLD WEATHER
[RURAL EDITION]

By the
INFORMATION BUREAU
UNIVERSAL PORTLAND CEMENT CO.

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Concreting in Cold Weather

There is a growing tendency on the part of rural contractors and farmers to find useful employment for their time during the seasons of the year when work is not pressing, and an increasing desire on their part to use this spare time in making permanent improvements. During the cold weather, the rural contractor and the farmer generally have plenty of time to work with cement, and there are many uses to which this material can be put in the winter as well as the summer. The contractor's season is lengthened and important work may be continued even if some emergency has delayed completion until cold weather. Of late years, large contractors in our cities have carried on, during cold weather, a considerable amount of concrete work of almost every description, with the same success which attends their efforts during favorable weather; and also the rural contractor or the farmer may, with the necessary precautions, engage in building certain classes of concrete farm constructions in cold weather, although for various reasons his scope is more limited than that of the city contractor. By doing a part of his concreting during the winter, the farmer relieves himself of this work during the busy season, thereby reducing the cost of his farm improvements.

Foundations and floors of barns, sheds and other buildings may be put in; concrete blocks, sills, lintels, slabs, fence posts and other products may be made within doors, and other work of a similar nature carried on, if the rules and suggestions for cold weather work, given in the following pages, are carefully complied with.



Figure 1—A concrete feeding floor will soon pay for itself in the feed saved and can be built during cold weather, provided proper precautions are taken to protect the surface after laying the concrete.

Effect of Temperature Conditions

It is clear that as water is an element required in bringing about the hardening of Portland cement concrete, the water must be kept in a fluid condition and not allowed to become ice. That low temperatures practically stop the hardening of concrete is admitted by all, the general opinion being that freezing will not damage concrete that has had a chance to harden for 48 hours under favorable conditions.

Hardening of concrete interrupted by freezing

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Concrete, frozen before hardening, may not be injured permanently if, upon thawing, it is not again frozen until it has had a chance to harden sufficiently to withstand subsequent freezing; but this condition seldom, if ever, occurs in practice. It is a recognized fact that alternate freezing and thawing at comparatively short intervals, during the first few days, will damage concrete. This condition makes it necessary to mix and place concrete in such a manner as to insure proper hardening before exposure to freezing temperature.

In many cases it is hard to determine to what extent freezing has injured concrete. Often the only effect apparent is a scaling of the surface, which of course is objectionable where a smooth finish is desired; but there is also the danger that freezing has so impaired the strength of the concrete as to render it unfit for the purpose for which it was designed.

Careful inspection of winter work is necessary before removing forms or subjecting the work to loads, for frozen concrete, although it will have but little strength when thawed, will ring when struck with a hammer and closely resembles in appearance thoroughly hardened concrete, sometimes showing a fracture through the aggregate when broken.

Precautions

Since freezing temperatures materially retard the hardening of concrete and injury is likely to result, it is obvious that precautions should be taken to enable the fresh concrete to acquire strength more rapidly and also to protect the work from the effects of alternate freezing and thawing until sufficiently hardened to withstand such treatment. The

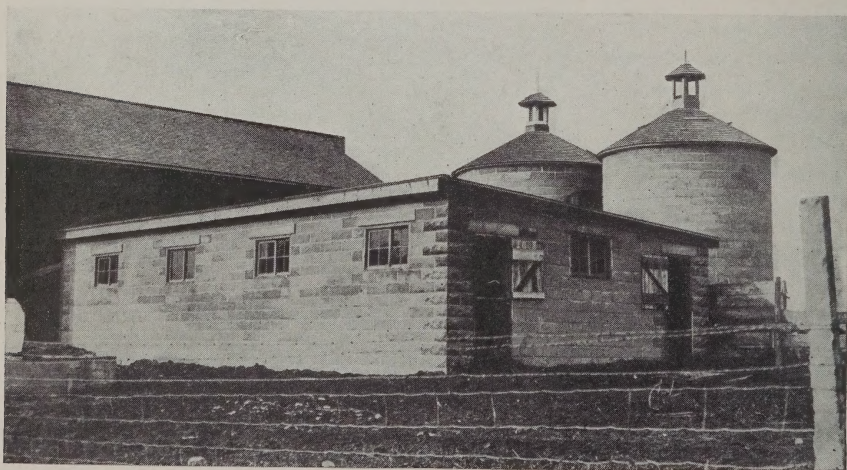


Figure 2—Dairy barn and silos constructed of concrete blocks. Substantial structures of this kind can be erected in very short time provided the blocks are previously made, ready to set up in the wall.

precautions necessary during freezing weather to insure satisfactory results with concrete depend upon the class of work. If proper steps are taken to protect the concrete, it is possible successfully to construct such work as building walls, columns, beams and roofs during the winter, and this class of work is now carried on by the large contractors regardless of season, but it will be found more economical for the farmer or the rural contractor to confine his winter operations to the more easily protected work, such as foundations, floors, low building walls, or cement products such as blocks, slabs and tile, which may be made indoors in temperatures above freezing.

Work can successfully be carried on during freezing weather by either or both of two methods: First, lowering the freezing point of the concrete, which is only effective for temperatures but little below freezing, and second: heating the concrete materials and then protecting the work until it has had a chance to harden.

*Two methods
for winter
work*

The Use of Salt

The use of ordinary salt is probably the cheapest method of lowering the freezing point of concrete. Various authorities have found that the addition of salt retards the setting and causes the concrete to gain strength more slowly than where not used, although unless the salt is used in excessive quantities the final strength is not lowered.

Sometimes salt is used when the materials and water are heated; but since salt retards the hardening of concrete and lowers its initial strength, while the heating of the materials and the mixing water accelerates that hardening and enables the concrete to gain strength more rapidly, it is evident that much better results would be obtained

*Heating
materials better
than using salt*



Figure 3—Effect of freezing on surface of sidewalk.

if the salt were eliminated and more attention given to heating the materials and protecting the concrete after placed.

Heating Materials

Elaborate and expensive plants for heating materials and protecting the concrete have been constructed and successfully used on important work. The additional equipment necessary for winter farm work, however, is comparatively limited, consisting principally of provision for heating the mixing water and materials. Barn floors and similar work may be protected by straw or manure, which is readily obtainable at practically no expense; or it may occasionally be necessary to use canvas for covering or housing in important work, and in such cases, it may be necessary to provide salamanders or some other means of obtaining artificial heat.

**Additional
equipment
not large**

During the winter months the materials are often full of frost and frozen lumps, and must be heated, as it is impossible to proportion and mix such materials properly. It is not necessary to heat the cement, however, since this material does not furnish such an appreciable percentage of the total.

**Materials
must be
heated**

The materials can be heated in various ways. For small work, one of the most convenient methods is by the use of a piece of old iron pipe. A pipe 14 inches in diameter and six to eight feet long is shown in Figure 4. This is laid on the ground, and a fire placed within. A considerable quantity of material may be heated by placing around the outer

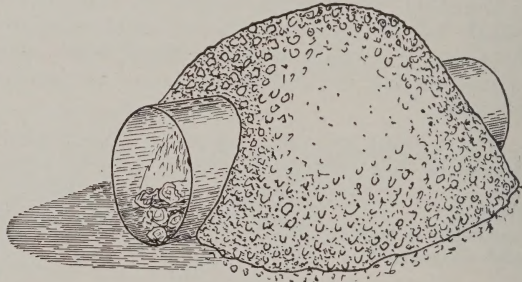


Figure 4—A piece of old iron pipe, 14 inches in diameter and six or eight feet long, will serve to heat the materials.

**Method of
heating materials**

surface of the pipe. A small furnace can be made of materials more readily obtainable and may be more handy to use than the pipe. A piece of No. 20 gauge corrugated sheet steel supported on three sides upon bricks, rocks or concrete blocks, as shown in Figure 5, will make a suitable furnace. The furnace should be about 24 inches inside width, and at least 6 feet long. Two such furnaces should be provided so that the sand and gravel may be heated simultaneously.

Half cylinders of sheet steel, set directly on the ground in the form of an arch, also make simple heaters for sand and stone. Old boilers can often be used for this purpose, as shown in Figure 6.

A portable heater used by the Chicago City Railway Co., and very convenient for small work is shown in Figure 7; a wood fire is built in one end and the heat circulates under the pan and up through the pipe at the other end. It takes but a short time to warm materials in this way. Figure 8 shows an old iron pipe being used for heating materials during the construction of telegraph conduits along railroad tracks in Chicago.

Too high a temperature injurious

In heating materials by the foregoing methods, too high a temperature will cause sand to turn red, while stone and gravel are apt to soften or crack. A temperature not to exceed 150°F. , will generally prove the most satisfactory.

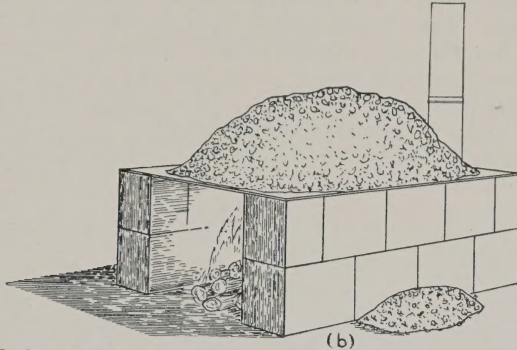


Figure 5—Small heating furnace of concrete blocks covered with an iron plate.

For rural work, where there is no running supply, water may best be heated in a large kettle or similar vessel like those used in making soft soap, maple sugar, etc. Where running water is available, a good way to heat the water is by a coil of pipe, which may be placed in the same fire as is used to heat the sand and gravel. A simple coil of 1-inch pipe will suffice. A barrel should be provided to receive the hot water and as soon as the barrel is filled the stream running through the coil should be cut down until it will exhaust steam which will then serve to keep the water in the barrel hot.

Heating the mixing water

During the construction of foundations for an apartment building recently, an interesting record of the temperature of the mixing water

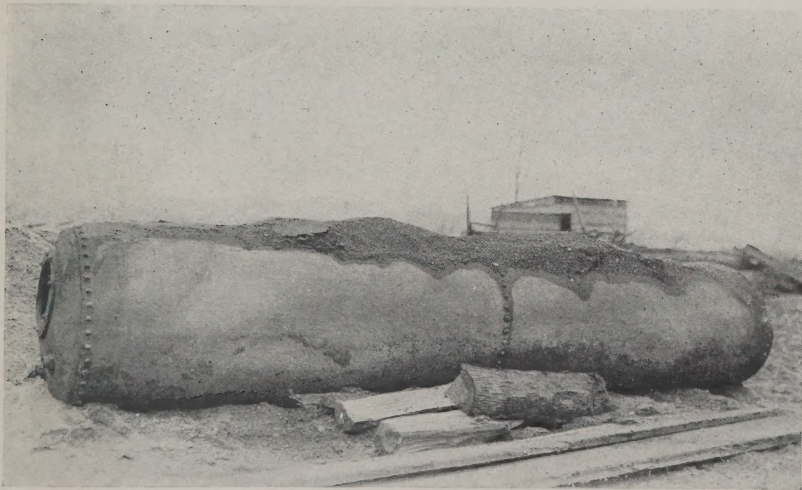


Figure 6—Old boiler used for sand heater.

was made. The temperature of the air was 34° , and the temperature of the water from the hydrant 40° . The water was heated by means of steam from a small boiler, the temperature for each of the thirty-four batches ranged from 112° to 172° Fahrenheit. The pressure on the boiler ranged from 30 to 40 pounds. Under these conditions, it was possible to place concrete in the work at a temperature close to 60° . Although these high water temperatures are unusual in rural work, the same kind of results, in a somewhat less degree follow the lower temperatures obtained where the water is heated without the assistance of steam.

The water heater illustrated in Figure 8 consisted of ten lengths of pipe about five or six feet long, so connected as to form a continuous



Figure 7—Portable sand heater used by Chicago City Railway Co.

coil. This was attached at one end to a hose leading from the water supply and at the other end to a hose which emptied into a barrel at the mixing board. After the barrel was filled with water, the valve of the supply pipe was partially closed as described, so that steam was generated in the coil and heated the water in the barrel; the barrel was refilled by allowing more water to flow through the coil. The sand used in the concrete was heated over the furnace that was used to heat the water; the larger aggregate, which consisted of crushed stone was not heated, but the subsequent temperature of the concrete would have been better had this been the case.

Heat introduced into the concrete by the use of hot water and heated materials and maintained by proper protection is supplemented by

internal heat which is caused by the hardening of the cement. It might also be stated that the heating of materials and the water not only hastens the rise in temperature, but also increases it somewhat above the temperature attained under normal summer conditions.

**Heat developed
in concrete
while hardening**

Mass Work

For heavy mass work, thick walls, abutments, etc., it may not always be necessary to heat the sand or stone if they are dry and free from frost. The water, however, should be heated, and if the concrete goes into place unchilled, it will harden quite rapidly, as mass work re-



Figure 8—Sand and water heater.

tains its initial heat for a long time, thus promoting hardening and the development of internal heat. If the forms are tight and made of

**Precautions
for mass
work**

heavy material it will only be necessary to protect the top or exposed surfaces of the work; this may be accomplished by covering with tarpaulins, or with boards, building paper or some other suitable material and applying a thick blanket of straw or manure. A thickness of from 10 to 12 inches of manure laid on paper or canvas will, if kept dry, protect work from freezing for days at a temperature as low as 10° F. Manure should not be placed directly upon the concrete, however, as it is very apt to discolor the work, and in some cases is thought to have caused a slight disintegration of the surface of the green concrete coming in contact with it.

As an additional protection for the concrete, building paper furred an inch or two from the forms has been found to be effective. Actual tests in practice have shown a difference in temperature of 15 degrees between the outside air and the space between the paper and the forms.

Floors

Greater precaution is necessary in laying floors during cold weather than is required for mass work, because the concrete exposes a larger surface for its mass when laid in floors, and has no forms to protect it, consequently the milder periods should be chosen for exterior work of this kind. Barn floors laid during winter should be put down in sections, so that part of the barn will be available while work is in progress. This is important, as floors laid in winter should not be used for a considerable length of time, since hardening is retarded by the cold. The floor should not be subjected to strains of any kind until it has developed practically its entire strength. All preparations for placing the floor should be completed before the actual work begins, so that no delay will occur while laying the slabs. The materials should be heated by the methods given in the preceding pages, or any other method which will do the work satisfactorily and conveniently.

Barn floors or other work where the surface need not be especially smooth may be covered with straw as soon as laid, to a depth of 10 to 12 inches. Dry manure should be used for this purpose, since manure containing moisture is liable to stain the concrete. Floors which are given a smooth trowelled surface may be covered with tar paper, upon which should be placed 8 to 10 inches of straw or manure. Tar paper is not apt to stain the floors, but any small stains which may occur may readily be removed with gasoline or kerosene, preferably the former, because it evaporates quickly. Especial care should be taken to protect exposed projections in the work.



Figure 9—Concrete posts have proven their worth for permanent fence construction. They can easily be made within doors during the winter months, and stacked up outside after hardening sufficiently in a warm temperature.

Cement Products

Concrete blocks, fence posts, window and door sills and similar work may be made during the winter time within doors, where the temperature need only be warm enough for the comfort of the operators. If a considerable quantity of sand and gravel is kept within the room where the work is done, it may not be necessary to heat them, provided the temperature is at least 40° to 50° F. At this temperature frost will disappear and frozen lumps gradually thaw out, if the pile is well raked over occasionally. Care must be taken to see that no frosty material or frozen lumps get into the work as matter of this kind is absolutely unfit for use and must not be permitted under any consideration, in the manufacture of cement products.

If the materials are brought in as used, provision must be made for heating, and any of the methods suggested in the preceding pages will probably be found suitable. The water should be heated where possible. Salt is not recommended for use in concrete block, sills or other cement products where appearance has to be considered, for although it will lower the freezing point of the mixture, efflorescence is likely to show.

The utmost care should be taken to prevent freezing during the first two or three days. After this time little damage can be done by freezing, although it must be remembered that cold weather retards hardening of concrete and causes it to acquire strength but slowly. Blocks, tile and other cement products made during cold weather should therefore be stored for a longer period of time before use, preferably until spring. Although work of this kind which has been frozen but once may ultimately acquire as great strength as work which has not frozen, it is much wiser to prevent freezing at the start and then store the work where of it will be protected from severe weather for several weeks. One of the best methods is by storing in a tight room, and covering with straw.

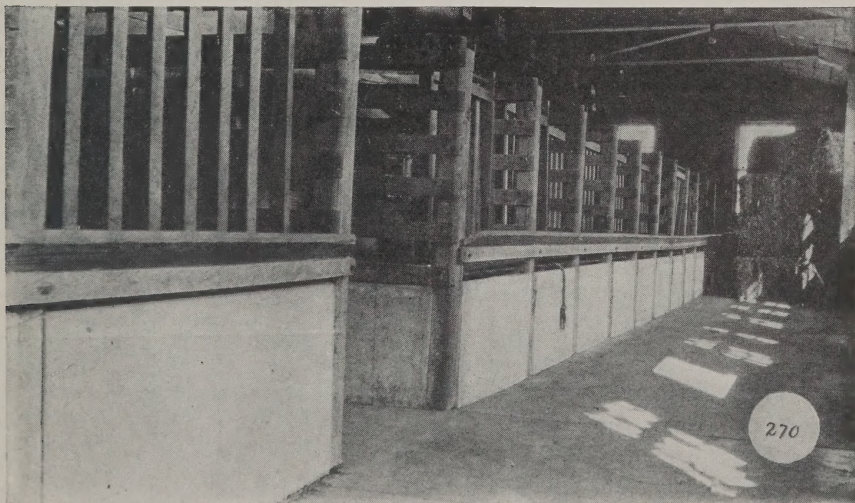


Figure 10—Winter is a good time to lay barn floors and mangers, since being housed in, proper protection is more easily provided.

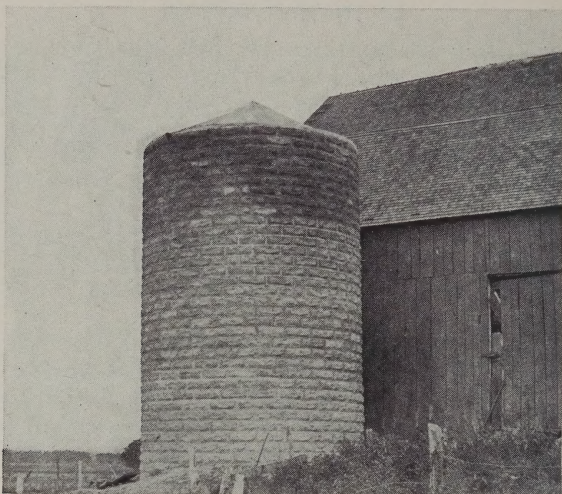


Figure 11—Chas. W. McNett of Carey, Illinois, is a firm believer in the economy of making concrete blocks during cold weather. The majority of his farm improvements of concrete are largely composed of concrete blocks which are made by the farm help while other work is slack.

Cold Weather Hints

THE hardening of concrete is hastened by heat and retarded by cold. Temperatures which may not be cold enough to freeze are often cold enough to delay hardening very materially. Don't expect concrete placed under such conditions to be safe for use as soon as if placed during warm weather.

¶ Examine all the materials before using in the work and be sure that they are not frosty or frozen.

¶ Take care that the materials are heated as uniformly as possible.

¶ See that each batch of concrete is placed in the work immediately after mixing. The temperature of the concrete when placed should not be below 50° F.

¶ Before pouring the concrete, be sure that the inside surfaces of the forms are free from ice and snow, and in very cold weather are warmed in some manner. Concrete should never be placed in steel forms until they are warmed, if the temperature is below 30° F. Hot water may be employed to warm the forms.

¶ If the work is delayed, cover the surface until concreting is resumed.

¶ Cover and protect any section of the work from freezing temperature as soon as completed. In cold weather keep work protected for at least five days.

¶ Examine the work carefully before removing forms. Frozen concrete will often ring when struck with a hammer and closely resembles in appearance thoroughly hardened concrete, even when broken.

INFORMATION BUREAU SERVICE

¶ The Universal Portland Cement Co. maintains an *Information Bureau* for the purpose of assisting its friends and customers in solving the problems constantly arising in the use of concrete. A corps of trained engineers answers inquiries and offers suggestions for the betterment of concrete work. This advice and help is free and involves no obligation whatever.

¶ In writing the *Information Bureau*, time will be saved if the inquiry is made full and explicit. Prompt attention will be given every request for information.

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